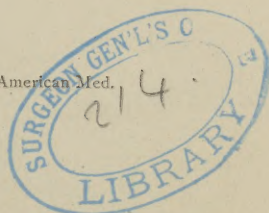


Marcy (H. O.)

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MICRO-ORGANISMS
TO SURGICAL LESIONS.

BY HENRY O. MARCY, A.M., M.D.,
OF BOSTON.

Read to the Section of Surgery and Anatomy of the American Med.
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Reprinted from the Journal of the American Medical Association,
November 1, 1884.

presented by the author -

CHICAGO:
REVIEW PRINTING CO.
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THE RELATION OF MICRO-ORGANISMS TO SURGICAL LESIONS.

The positive demonstration of the important factorage of bacterial growths in surgical lesions would seem no longer wanting. The recognition of this in the evolution of the systems of modern wound treatment is apparent.

The ill effects of the retention in wounds and cavities of the secretions contaminated with putrefactive bacteria have long been recognized, yet, it has remained for modern investigators to demonstrate that this ill effect is owing to germ development. It would have appeared easy of inference, that this was due in some way to atmospheric, and since the knowledge of the causes of fermentation, to a particulate organic infection, since very severe lesions, attended with abundant exudation, commonly recover without supuration, when the skin covering the wound is unbroken. When these exudations undergo fermentation from the growth therein of micro-organisms, there is generally developed an entirely new and different class of symptoms, both local and constitutional.

I am ready to admit that many questions of great magnitude remain unsettled, that many subjects connected therewith are shrouded in doubt and obscurity, and that many fields of great promise remain yet for exploration. While this may temper our zeal and cause us to examine with double caution our premises and conclusions, it can not the less stimulate every thoughtful student to better endeavor and renewed effort.

Dr. Pilcher, in his recent excellent work upon "The Treatment of Wounds," defines aseptic wounds to "include all which are preserved from contamination by poisonous materials, whether such poison be applied directly to it, or be generated in it by the action of germs that gain access to it and find within it the conditions favorable for their growth. An aseptic condition in a wound may be obtained, either by the protection which the wound receives from the first against the access of any septic agent, or by the power of living tissues to resist and destroy septic agents, or by the application to the wound of substances which destroy them. Examples of the first class are presented in subcutaneous wounds, and in operative wounds which are inflicted with certain precautions; examples of the second class are seen in all open wounds in which union by first intention is secured, notwithstanding at the time of their infliction they were freely exposed to ordinary air; examples of the third class are presented by wounds in which the application of antiseptic substances has been successful in arresting the action of whatever septic agents may have previously gained access to them. Asepsis in a wound is of the highest importance. As long as it is maintained, no decomposition of the secretions of the wound takes place, no sloughing of killed or partly killed tissue occurs. When the proper cares to favor the nutrition of the wounded tissue are rendered, the healing of the wound progresses without pain, inflammation, or suppuration, and the least possible amount of cicatricial tissue is produced. To secure an aseptic condition in a wound, or to approach it as nearly as possible, is the first and most important indication in wound treatment."

I have myself elsewhere given the definition somewhat epigrammatically, as a wound surgically clean, and this for our present purpose would serve for the

distinction between aseptic and septic wounds. Although seemingly lost sight of in many of the heated discussions upon this subject, the great fundamental factor of repair, the *individual vital force*, under conditions favorable, or otherwise, must ever hold the first place.

This, however thoughtfully considered, can never be fully resolved and in individual instances expressed in known terms, but remains somewhat as an X factor in the equation of life's processes, like the estimate of a business man's fortune, subject to modifying influences, both inherent and extraneous, and never to be fully inventoried, until the estate is finally settled. These varying factors may be catalogued, as race, age, idiosyncrasies, mental state, constitutional condition, disease, hygienic surroundings, etc.

Bioplastic or living matter possesses in itself, in greater or less degree, the power of resisting extraneous influences. This power to maintain the equilibrium of the active, functioning state of the organism, although possessed in a greater degree in the higher and more complex forms of development, is ever subject to the influence of its surroundings. These must be the more important to the individual having suffered devitalization from injuries. Hence, the thought long bestowed upon the sanitation of the wounded, pure air, sunlight, careful cleanliness of person, clothing, room, etc. In a general way all these may be considered antiseptic conditions of the best character, yet pure air does not destroy the particles of infection, it only dilutes them. The sunshine and fresh air add to the bioplastic power of the tissues and give increase of individualistic function to resist the influence of deleterious agencies.

Time fails to pass even in rapid review the painstaking labors and researches for the ultimate causes of the changes which result in the disorders of re-

pair. Most of us remember the long and seemingly fruitless discussion upon the question of spontaneous generation. The result of all this has been the final demonstration to the acceptance of the scientific world of the particulate theory of fermentation. We are especially indebted to the researches of Pasteur, Tyndall and Lister, for the setting at rest this vexed question, and to the latter, for the application of the deduction, that from such causes there resulted dangers to wounds and often to life.

The best methods by which to limit, lessen and control, if not to destroy the causes of these dangers was the self-imposed task of the enthusiastic innovator who, true to the divinity of his inspiration, has labored all these years with a singleness of purpose rarely surpassed.

The very meaning of the Greek word *septikos* signifies, that which *causes* putrefaction, and per consequent, antiseptic can have but the one meaning, that which is directed against the *causes*, not the effects of putrefaction. If it be true, that putrefaction cannot take place without fermentation, and fermentation is almost without exception caused by the growth of the lowest orders of the spore-producing plants, it would seem simple to formulate, that to the rôle of these micro-organisms should be ascribed the putrefactive changes and their deleterious consequences, incident to open wounds. Thus these organisms, so minute as to have escaped, in the main, the notice of most observers in the early days of microscopic training and study, or as at the most incidental and unimportant, have recently acquired an interest of primary character not alone to the surgeon and physician, but also in no less degree to the sanitarian.

The best illustration of an aseptic wound is one where nature herself has given it the safest protection from deleterious external causes, by keeping it still

covered by the unbroken integuments. A subcutaneous injury has from time immemorial been recognized, even by superficial observers, as one of distinctive differences of danger and course of repair, from one where the injury is simply augmented by the laceration of the skin. None have contended that it was the simple factorage of broken integument that rendered the difference, but the causes have been more commonly sought in the various modifications induced by atmospheric exposure and consequent chemical changes.

Defects of bioplastic power, both constitutional and local, result in disorders of repair; defects of apposition prolong the process and make extra demands for reparative material; but in defects of *protection* are found conditions which produce arrest of reproduction and destruction of the adjacent tissues. It is clearly established that the disturbing elements arising from atmospheric contact come only from the organic, living particles which it holds in suspension (germs), and these spores under favorable conditions rapidly germinate. These minute organisms are seemingly omnipresent. They develop in the secretions which issue from the animal economy, infest the skin, literally devouring its waste, a hundred feasting upon a single epithelial scale, and they reproduce in myriads in the alimentary canal. Notwithstanding all this, these organisms are never found in the tissues of the healthy living body, and to a certain extent, these tissues are endowed with the power to resist their action and even to produce their destruction when brought in contact. It must be ascribed to this power in living matter, that the germs which have gained access to the tissues through a wound often do not develop, when speedy and complete approximation of the parts has been effected.

This has long been recognized as primary union in wounds, and has often been held in illustration that

antiseptic methods were, in at least certain conditions, unnecessary, and that these minute beings, after all, could not be capable of such dire disaster as has been claimed to result from their development. Given a wound where approximation fails, and a fluid exudation fills a hidden recess, and here we find most favorable conditions for germination after such atmospheric infection, and a long train of deleterious results, frequently ending in death, ensues.

The form of germs which produce fermentation may be classified under three general types—the micrococcus, the bacillus, and the yeast cell. Varieties known as bacteria of different forms may be referred to one or another of these types. The yeast plant only develops in the fermentation of saccharine materials, and plays no part in surgical affections. Bacilli and micrococci require albuminoid compounds for their development. Both forms are usually found in open wounds. When the micrococci only are present, we have decomposition without odor, but the development of bacilli is always accompanied with odor more or less fetid. According to Ogston, the occurrence of a putrid odor is absolutely sure to indicate the presence of some of the varieties of the rod-bacteria. According to Cheyne, the more putrid the discharge the more numerous and smaller are the bacilli. These organisms have less inherent vitality than micrococci. They limit their invasion to material already devitalized, and are never found in the living tissue. These bacilli are comparatively easily exterminated from a wound, by the removal of the decomposing material necessary for their consumption. They are also quite readily acted upon by the various germicides and destroyed.

The spherical organisms, micrococci, on the contrary, are much more difficult of extermination. They reproduce in chains and masses, and in the latter form are found frequently colonizing in different parts of

the body; thus they not infrequently obstruct and dilate a capillary vessel, and cause widely disseminated abscesses, as in pyæmia. They vary greatly in number. Ogston estimated that in one specimen of pus one cubic millimetre contained 45,000,000, while two other specimens of the same bulk contained less than 1,000.

They are cultivated without the production of any especial odor, and generally their presence in a wound is not indicated by any change perceptible to the olfactory sense, except perhaps a slightly sour smell. There can be little doubt that there are varieties of micrococci identical in appearance, as exhibited by any means yet devised, but which nevertheless possess extremely different capabilities and characteristics. Some are comparatively harmless, others in the highest degree virulent.

Sternberg states: "Some are pathogenic, others are not; some develop in the blood of certain animals, others will not. Different species multiply in different media, and are destroyed at different temperatures. A nutrient medium which has been exhausted for one micrococcus may not be exhausted for another."

Cheyne describes and figures micrococci developing in wounds in large numbers without causing any serious injury. These varieties, when injected into the bodies of animals, produce entirely different results. Some develop and cause local abscesses, or a rapid and fatal blood-poisoning, while other specimens scarcely produce even any local suppuration. The inflammation and subsequent blood changes are usually far more active in the pus from open wounds than from acute abscesses.

According to Ogston the grouping of the micrococci seems to modify the result, and the chain form rarely if ever passes into that called zoöglea or masses. In the erysipelatous type, affecting the lymphat-

ics, the chain form predominates, while in suppurative inflammation in the tissues the forms are grouped.

Fehleisen, of Berlin, published last year the result of his studies upon erysipelas and demonstrated the active factorage of the form of micrococci developing in chains in erysipelas. He not only examined them during life, but he cultivated them and with equal success inoculated the cultures, producing the disease in its typical forms in man and animals. I have cultivated the micrococcus of erysipelas from several sources. It reproduces in marvellous numbers with extreme rapidity. My inoculation experiments failed, but they have been too limited to be of any practical value.

The researches of Koch, Pasteur, Ogston, Cheyne, Sternberg, Klebs, and others scarcely less known, can only be referred to, but all more or less clearly point to the demonstration that there are different varieties of micrococci, not distinguishable in form, possessing widely different characteristics. The origin of the micro-organisms found in certain locations presents a problem of very difficult solution.

A few months since, a woman in excellent general health felt something, as she expressed it, "give away in the bowels." Peritonitis rapidly developed and death supervened in forty hours. The autopsy showed an ovarian cyst, not larger than an egg, partially empty. There were several pints of a slightly opalescent, flocculent serum in the abdominal cavity. The fluid was swarming with a large bacillus which multiplied with extraordinary rapidity in culture tubes. This bacillus was also found in the contents of the cyst. The cyst was evidently an old one, with a wall thick and friable.

Only a few weeks since, an ovariectomy furnished this interesting history: I removed a compound cyst with multiple adhesions. The cysts were thin-walled and several were broken in the removal. The cleans-

ing of the peritonæum was made with care by sponges moistened with 1-1000 bichloride of mercury. Examination of the urine previous to operation gave no evidence of renal disease. Albumen with casts appeared in the urine at the close of the second day. Suppression of urine followed and death ensued between the third and fourth days. At autopsy there was no evidence of peritonitis, only a very little reddish serum in retro-uterine pouch, which contained active micrococci. The kidney was in a state of acute parenchymatous nephritis and the capillaries were filled with masses of micrococci. The tumor had been preserved in a 1-1000 solution of bichloride of mercury and in a number of the unopened smaller cysts were numerous micrococci.

The inferential evidence that the patient's death was due to infection from this source appears very strong.

Dr. Drysdale, of Philadelphia, who has very probably studied the morphological conditions of ovarian fluid more carefully than any other, writes me, "he has no recollection of finding micro-organisms in ovarian fluid uncontaminated by atmospheric exposure." It is equally difficult to explain the origin of the micrococcus of pus uniformly found in acute abscesses where the integuments covering them are still unbroken. The evidence is demonstrative that the blood of healthy animals does not contain micro-organisms. In a series of abscesses, eighty-two in number, examined by Ogston with due care, no organisms were found in thirteen purely chronic. In four subacute and sixty-five acute abscesses micro-organisms were found. They were in chains, zoöglea masses, and in groups of three or four.

I have more ordinarily found them in short chains, twos or fours, or groups of three or four, rather than in zoöglea masses. It is not known if the forms pre-

sented are of significance, very probably only showing the forms of growth by subdivision.

Although much remains to be studied and settled beyond dispute, the proof, that micrococci are the essential cause of suppuration, is rendered very strong by the results of inoculation, by which it has been shown that pus devoid of micro-organisms, for example, that subjected to heat or an efficient germicide, or the pus from a chronic abscess, is innocuous when injected into the tissue of animals, while pus containing micrococci, even in minute doses of a minim or more, invariably occasions well-marked disease. Interesting as is the subject we must not pursue this line of inquiry farther, simply stating that experimental proof is constantly accumulating to show that the inflammatory and other changes which ensue in wounds, producing often the most serious and dangerous consequences, are with few exceptions the result of the vital activity of new organisms.

The result of the observations and experiments of Ogston has led him to conclude that septicæmia, pyæmia, and septic pyæmia are one and the same disease, and that their sole and invariable cause is micrococcal poisoning.

Belfield, in his interesting lectures given last year in New York city, sums up the question as follows: "A review of the evidence already considered shows, then, that infectious diseases, identical in clinical and anatomical appearances with the various forms denominated septicæmia in man, have been induced in the mouse and rabbit by inoculation with animal tissues in various stages of putrefaction; that the resulting infection is just as certain if the putrid substances be previously boiled and thereby deprived of living organisms. On the other hand, it is certain that *per se* innocuous culture fluids, infusions of beef, etc., acquire after inoculation with minute quantities of infected blood or tissue, the same septic properties,

provided such blood or tissue contain living bacteria ; it is further certain that this multiplication of the septic substance in such liquid is a concomitant of the vital action of the organisms therein contained ; it is further demonstrated that these organisms can and do not alone multiply in the septic material, but, when isolated by successive cultures from all the accompanying animal tissues, induce independently fatal infectious diseases. The same principle, vital activity of bacteria, pervades all these phenomena ; for the artificial induction of septic diseases has been, in all these experiments, originally accomplished by the incorporation into the animal of putrid tissues, with or without bacteria. Now, since putrefaction must be regarded, in the present state of our knowledge, as impossible without the presence of these organisms, it is evident that sepsis, putrid infection, was in every case due, directly or indirectly, to the action of bacteria ; since even the boiled substances used by Panum and Rosenberger, and the sepsin obtained from rotten yeast by Bergmann and Schneideberg, had acquired their septic properties through putrefaction ; *i. e.*, through the action of bacteria. Hence we are logically driven by all this work, to the belief that septicæmia implies the introduction into the animal, either of living bacteria, or of a substance which has acquired noxious properties through previous vital activity of these organisms."

The experiments of conversion of innocent into malignant forms, and *vice versa*, are unreliable.

In a previous contribution, "Upon the best Methods of Wound Treatment," I endeavored to show that the best methods were those based upon a broad, comprehensive knowledge of a scientific character, including such factorage as we have here under discussion, and that the too commonly held ideas of antiseptic surgery, as consisting of carbolic acid ap-

plied as spray or in dressing, were not only superficial and misleading, but distinctly incorrect and injurious. Such imperfect knowledge of any scientific truths must have its fruitage only in evil, leading to a distrust in methods, at the best only half understood, and the results obtained, where protection in wounds has not been secured, are falsely reported in proof that antiseptic surgery is only the fashion of the hour, an exploded theory which should be relegated to the long list of isms and pathies which have for so long justly placed our profession in derision.

APPENDIX.

Since the reading of this paper the following was published :

The most valuable of recent contributions upon the relation of micrococci to wounds, abscesses, and septic processes, is the report to the Scientific Grants Committee by W. Watson Cheyne and published in the British *Medical Journal* during September and October, 1884. I should do the subject injustice without giving briefly his conclusions :

1. "There are various kinds of micrococci found in wounds treated aseptically, differing markedly from each other in their effects on animals. They agree in growing best at the temperature of the body, and in causing acidity and sweaty smell in the fluids in which they grow. The experiments show that cultivations may be carried on in fluids with accuracy, provided the precautions mentioned be observed.

2. The micrococci tested in these experiments grew best in materials exposed to oxygen gas. They grew only with difficulty in the absence of oxygen. Eggs were not good pabulum.

3. Their effect on animals was not altered by growth with or without oxygen.

4. The effects of these micrococci on rabbits and

man were not similar, some of the most virulent forms for rabbits causing no deleterious effect in wounds in man.

5. The kidney is apparently an important excreting organ for organisms.

6. Organisms not capable of growing in the blood may yet cause serious effects by growing in the excretory canals. This may explain some cases of pyelitis.

7. Where an organism is not markedly pathogenic, it may be necessary to introduce a large quantity before morbid changes are set up.

8. Supuration is not always due to micrococci, it may be caused by chemical irritants, such as croton oil.

9. Micrococci are always present in acute abscesses, and are probably the cause of them.

10. In some cases, the micrococci are the primary cause of inflammation and suppuration, as in pyæmic abscesses; generally, however, they begin to act after inflammation has been previously induced.

11. This inflammation may be caused by an injury, by the absorption of chemically irritating substances from wounds, by cold, etc.

12. There are several different kinds of micrococci associated with suppuration.

13. Micrococci cause suppuration by the production of a chemically irritating substance which, if applied to the tissues in a concentrated form, causes necrosis of the tissue, but if more dilute, causes inflammation and suppuration.

14. The conditions in wounds and abscesses are not the same, inasmuch as in the former there is opportunity for mechanical and chemical irritants to work.

15. There is no reason for denying the existence of "antiseptic suppuration."

16. Tension may also cause suppuration, but it is

perhaps most frequently aided by the growth of micrococci. These organisms need not be of a very virulent kind. It is also probable that the products of inflammation are themselves irritating and capable of exciting or keeping up inflammation.

17. The micro-organisms of septicæmia, of pyæmia, and erysipelas, are different from one another and from those of abscesses. In erysipelas, the micrococci grow in the lymphatic spaces. In pyæmia, they grow in the blood to form colonies and emboli. In septicæmia, they may only grow locally, the symptoms being due to the absorption of their ptomaines; or if they grow in the blood they do not form colonies and emboli. Septicæmia may also be due to other organisms besides micrococci.

18. There are no facts to support the view that it is the same micrococcus which, under different conditions, causes these various diseases.

